Erie-Lackawanna Railroad and Ferry Terminal,
Ferry Slips and Bridges
Bounded by Observer Highway on the south,
Newark Street on the north, River Street
on the west and the Hudson River on
the east.
Hoboken
Hudson County
New Jersey

HAER No. NJ-59

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
MID-ATLANTIC REGION NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR
PHILADELPHIA, PENNSYLVANIA 19106

HISTORIC AMERICAN ENGINEERING RECORD

Erie-Lackawanna Railroad and Ferry Terminal, Ferry Slips and Bridges

HAER No. NJ-59

Location:	Bounded by Observer Highway on the south, Newark Street on the north and River Street on the west, and the Hudson River on the east. Hoboken, Hudson County, New Jersey Quad: Jersey City
Date of Construction:	1907
Designer/Builder:	Designer: Kenneth Murchison
Present Owner:	New Jersey Transit McCarter Highway and Market Street P. O. Box 10009 Newark, New Jersey 07101
Present Use:	None
Significance:	Throughout the early decades of the twentieth century, this terminal played a central role in commuter transportation in the metropolitan area. The ferry facilities are significant as an integral part of this complex. In addition, the copper ornamentation on the ferry shed facades is unusual, as is the engineering design of the ferry bridges.
Historian:	Celia Orgel, August 1983
Retyped and Transmitted by:	Jean P. Yearby, HAER, 1987

Ferry service from Hoboken, New Jersey, to New York City began in 1775. It continued for nearly 200 years with only one interruption for the American Revolution. The last episode in this ferry's history began in 1907 when the Delaware, Lackawanna, and Western Railroad Company built a new railroad and ferry terminal designed by Kenneth Murchison (Smith, 1931). This complex, now known as the Erie Lackawanna Railroad and Ferry Terminal, included six ferry slips for boats which traveled between Hoboken and Barclay, Christopher, and Twenty-third Streets in Manhattan. This service was abandoned in 1967 because of the greater efficiency offered by tunnels, automobiles, and mass rapid transit. Today, 1983, four of the deteriorating ferry bridges are scheduled for removal under the New York Harbor Collection and Removal of Drift Project, sponsored by the Army Corps of Engineers and the State of New Jersey. Ferry fenders and two ferry bridges will be stabilized under this project with funds from the New Jersey Department of Environmental Protection and the Army Corps of Engineers. The ferry bridges were among the distinctive engineering features of this transportation complex.

Need for New Terminals in New Jersey

The Delaware, Lackawanna, and Western Terminal was built in response to a pressing need for rail and freight facilities in the late nineteenth century. There were fast-growing populations in New Jersey cities across the Hudson, as well as in the outer boroughs of New York City. These communities were expanding more quickly than Manhattan, the business hub of the city. However, the railroads which carried the New Jersey commuters stopped short of Manhattan, terminating on New Jersey waterfront of the Hudson and the Upper Bay. To complete a trip to the city, travelers relied on ferry service. As Carl Condit remarked in his history of the harbor, "the dependence of the metropolitan area on ferry transportation was nearly absolute, and the extent of these maritime operations was unparalleled among the cities of the world" (1980: 241). In the first decade of the twentieth century, 41 ferry routes united Manhattan, New Jersey, Long Island, Staten Island and the lesser islands of the Upper Bay and East River, transporting about 625,000 passengers each weekday (Condit, 1980: 241).

In New Jersey, the need for new terminals was acute by the 1880s. Jersey City had increased in population thirty times by the end of the century and Hoboken's populace had multiplied twenty-two times. By 1892, four new passenger stations had been built along the waterfront here. By the end of this period of railroad expansion, nearly the entire New Jersey waterfront was used for passenger and freight terminals. Work on the Hoboken terminal, however, did not begin until the end of this period. Plans were not developed until 1905, when 100,000 people were passing through the terminal daily (Engineering Record, 1905: 492; Condit, 1980: 127-134, 169).

Design of the Hoboken Terminal

Planners under Murchison's direction designed the terminal to accommodate pedestrian traffic as well as the requirements of trains and ferries. From the ferries at Hoboken, commuters traveled home by train, trolley, or on foot, so that the terminal functioned as "a kind of funnel through which people flowed between ferries and other modes of transportation (Condit, 1980: 169). Accordingly, the ferry slips were situated so that ferry passengers could pass directly to or from other modes of transportation on the Hoboken street level without passing through the railroad terminal. This innovation set the Hoboken terminal apart from others built at the time. It resulted in the two sections of the terminal coming together at an oblique angle, unlike the typical right-angled form created by other terminals.

The ferry concourse was an elaborate multi-level affair, designed to keep commercial and commuter access separate. The spacious upper passageway was unusually luxurious, paneled with mahogany and cherry wood and trimmed with gold. A barber shop, first aid station, toilets, and a large elegant restaurant with river views opened onto the concourse (Florio, 1982: 6-7).

The ferry slips themselves were also noteworthy for the decorative copper-clad arches which framed each of these. Neoclassical ornamentation was pressed into copper ellipses which were designed by Murchison. The Hoboken ferry slip facades were similar to ones the same architect designed for the Twenty-third Street ferry station in Manhattan in 1904 (Clark, 1977: 18). (This structure is no longer extant).

The ferry landing bridges were considered important as well at the time of construction. Engineering News included diagrams and a description of them in an article devoted to the new terminal in 1906 (Hurlbut, 1906: 297-304). Eugene W. Stern designed the bridges and received a patent for his invention in 1907. His design included a two-tiered structure which, the inventor claimed, permitted "a more effective and inexpensive means for adjusting the terminals of both the upper and lower decks...than by those in vogue" (Stern, 1907: Patent No. 848,862). Stern also claimed that this design incorporated a safety feature which provided for flexibility of the structure in the case of collision with a ferry.

Ferry Bridge Design

The upper deck of each bridge was supported by columns carried on the main deck bridge, so that the two attached decks moved together with the tide or through mechanical adjustments. At the shore end, the lower bridge was supported by piles to which it was connected by bearing sockets and rockers.

The forward end of the bridge was supported by a pontoon, as well as by a roof truss from which chains and counterweights were suspended. The pontoon carried most of the weight of the free end of the bridge, while the chains and counterweights were used to adjust the bridge in accordance with the level of the ferry, depending on the load it carried. Most other ferry bridges in the harbor apparently relied on overhead rather than pontoon supports.

A forerunner of the pontoon bridge was employed by an early operator of the Hoboken ferry, Colonel John Stevens. Col. Stevens had bought the land on which Hoboken rests in 1784; in the early 1800s, he ran steam-powered ferries of his own invention between Hoboken and Manhattan. To boost passenger business, he provided floating stairs, which rested on a pontoon and rose and fell with the tides (Smith, 1931).

The movable upper deck of Stern's patent bridge was divided into three sections. The short end was attached by pin to the gallery of the ferry concourse and was also supported at the outer end by columns, as stated above. Each upper bridge was supported by two pairs of these columns, each pair connected by a girder, forming an arch. A passageway, 8' 7-1/2", for pedestrians was carried above each of these arches. Between the two pairs of columns was a connecting truss.

The middle portion of the upper deck was attached to the inner portion by a pin. Columns provided cantilevered support. The short forward apron of the upper bridge was pivotally supported.

An unusual support base for the columns comprised what Stern termed the safety feature of this structure. The supporting columns rested on rails, along which they could slide forward in the case of collision. In addition, the flexible connections on the upper bridge would, in this event, cause the forward parts of the upper bridge to rise clear of the ferry and thus protect the structure from damage.

The fundamental difference between this and other ferry bridge structures was the connected upper and lower decks. Other ferry bridges had either one deck or had separate upper and lower decks which had to be adjusted independently by two attendants. Stern stated that his bridge only required one person to operate it (Stern, 1907: 848, 862).

Use of the Stern Patent Bridge

Shortly after the new Hoboken ferry terminal was built, new ferry facilities were also constructed at St. George, Staten Island and at Liberty Street in Manhattan. Several years later, another new ferry terminal was built at Whitehall Street in Manhattan (Engineering Record, 29 June 1907; 11 June 1908;

7 November 1908; 29 May 1909). Apparently none of these facilities included the Stern patent bridge. A search of the Industrial Arts Index and the Engineering Index for the decade following the construction of the Hoboken terminal suggests that no other Stern bridges were built at major terminals in the United States. Within New York Harbor, the Hoboken bridges are the only known examples of this design.

It is not immediately apparent why Stern's bridge was not more generally employed. It was not because of an absence of ferry-related construction following his invention. Even as late as the 1940s and 1950s, the ferries operating out of Whitehall Street in Manhattan and St. George in Staten Island were motorized and modernized. However, no provision was made to follow Stern's lead and attach upper and lower decks (Roberts and Schaefer, 1955). In 1983, two people are still operating each set of upper and lower bridges at the Whitehall ferries.

In the early years of this century, companies have preferred to have their own engineers design ferry bridges despite any advantages offered by designs of their rivals simply because this was typical of the competitive spirit of that era. However, recollections of Jack Quinby, a Hoboken ferry worker in the 1950s and 1960s, suggest that Stern's bridge was rather complicated to operate and was neither safer nor cheaper to run than other ferry bridges, despite Stern's claims. If this was the case, the bridges would not have been worth duplicating.

Quinby's Recollections

According to Quinby, the pontoon which provided support for the lower bridge looked like a large wooden box. Because it was not waterproof, it had to be pumped out periodically. A small hatchway on the lower bridge provided access. Behind the bridge was a rolling log, hooped with iron for support. Additional support came from three platforms behind the apron which rested on 100 piles.

Ordinarily, the bridge floated with the tide and was adjusted manually only about six inches through the use of an eight-spoke wooden wheel and hemp rope attached to the lifting mechanism. Two toggles were on the end of the float or pontoon. The ferry boat slid in underneath these when it came to dock. Throughout the life of ferry operations, the bridges were manually adjusted in this way. Elsewhere in the harbor, electrically-powered bridge lifting mechanisms were installed (Quinby, 1983).

Stern apparently did not foresee that. Because of the way the Hoboken bridges functioned, it was possible to "hang a bridge," that is, to leave the wheel hooked as the tide went out. This left the bridge raised during an ebb tide. Instead of floating on its pontoon, the bridge was hanging with all its weight suspended from the roof trusses, which were not meant to support such weight. If a bridgeman hung a bridge, he was given a week off without pay. The bridge could be brought down with tow jacks, but this was a major job. Thus, the pontoon support system was rather vulnerable (Quinby, 1983).

The safety feature of the bridge may also not have functioned as was intended. Quinby, recalling accidents which occurred during his tenure with the ferry, could not remember any incident in which the columns supporting the upper bridge slid along their rail base. He did recall one accident in 1960 which he did not witness, involving the ferry Pocono. Its engineer apparently did not heed the boatman's maxim, "When in doubt---back," and he collided with the slip, which required substantial repairs.. The engineer was subsequently demoted to oiler. Presumably, the safety feature of the bridge did not prevent serious damage from occurring.

As a result of this accident, the Coast Guard insisted the company install a telegraph to aid communication. Prior to this, the engineers and bridgemen relied on gongs. Other means of communication at the ferry terminal included a hand-cranked magneto telephone which linked Hoboken to other terminals in the harbor via a private line (Quinby, 1983). According to one account, the terminal was the site of the first wireless telephone installed to operate between Hoboken and Manhattan (Hudson Dispatch, 20 March 1955).

A system of colored lights, established by the Coast Guard, allowed ferry engineers to know one another in light or in foggy weather. Each company was assigned a color for lights, known as route lights. The lights, originally oil lamps, then electric, were atop the tallest staff of each boat and also on each ferry rack. Lackawanna's color was white (Quinby, 1983).

Fog bells were also used. These bells, especially made for the ferry, were nearly five feet tall and were placed at the end of the racks. One bell was at Barclay Street, one at Christopher, two at Hoboken, one at Twenty-third Street, and one at Fourteenth Street (Quinby, 1983).

At the Hoboken terminal in the earlier years of its operation, a novel form of internal communication was used. When the ferry bridge apron or pontoon made contact with the boat, an electrical circuit was closed and a light illuminated the train board so that disembarking passengers knew when a ferry was in the station (Quinby, 1983).

Stern's innovative attached upper and lower decks did not function as planned, according to Quinby. Although Stern stated that only one worker was needed to adjust the bridge, two people were actually used on the Hoboken ferry: a regular bridgeman and an upper apron bridgeman. However, the upper deck bridge was only in use during rush hours. At other times, only the lower bridge was open.

Some of the ferries used at Hoboken were originally one-decked boats to which a second boat was added, making them top-heavy. These ferries included the Oswego, the Hamburg, and the Netherlands. Others, built with two decks, were the Pocono, the Elmira, the Ithaca, the Binghamton and the Scranton. The Hoboken ferries were the only spoon-bow ferries in the harbor, according to Quinby. They curved up at the bow.

The Hamburg, built in 1891, was converted to a diesel in 1949. Its name was changed to the Chatham and then it became the Lackawanna. In 1983, it is now being taken apart for scrap at Rossville, Staten Island, over 90 years after it was built. Its deck is Hudson Valley Oak (Quinby, 1983).

A distinctive feature of the ferries and slips, which was unrelated to Stern's patent, was their size. The ferry slips at Hoboken were too narrow for other companies' ferries to use. Because the Hoboken ferries themselves had such narrow bows, they could dock in any other ferry slip in the harbor (Quinby, 1983).

The Erie-Lackawanna Terminal is currently undergoing renovation. An outdoor plaza is planned, as well as film studios for the interior. The railroad station remains active but the ferry facilities are unused. There are no plans at present to operate ferries out of Hoboken, but it is likely that some ferry service between New Jersey and New York will soon be reestablished. Waterfront residential development along the Hudson River in New Jersey is expanding rapidly and a demand for pedestrian commuter service is once again being created. Thus, it may be that before the close of the century, the Hoboken ferry will again play the central role in commuter transport it did in earlier years.

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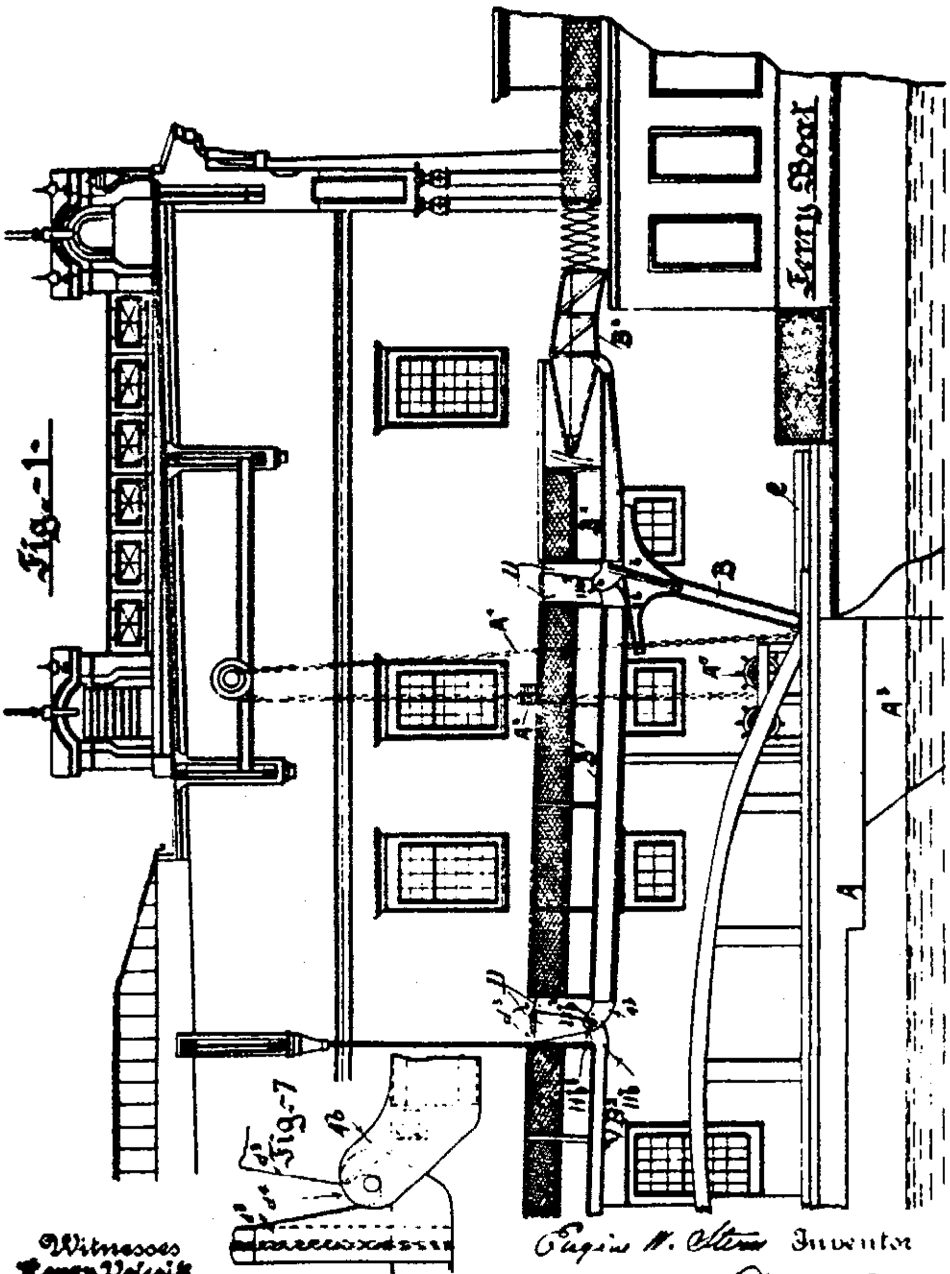
No. 848,862. PATENTED APR. 2, 1907.

E. W. STERN.

FERRY BRIDGE.

APPLICATION FILED JULY 19, 1906.

6 SHEETS—SHEET 1.



Witnesses
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John Hogg

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By his Attorney Philip K. Stern.

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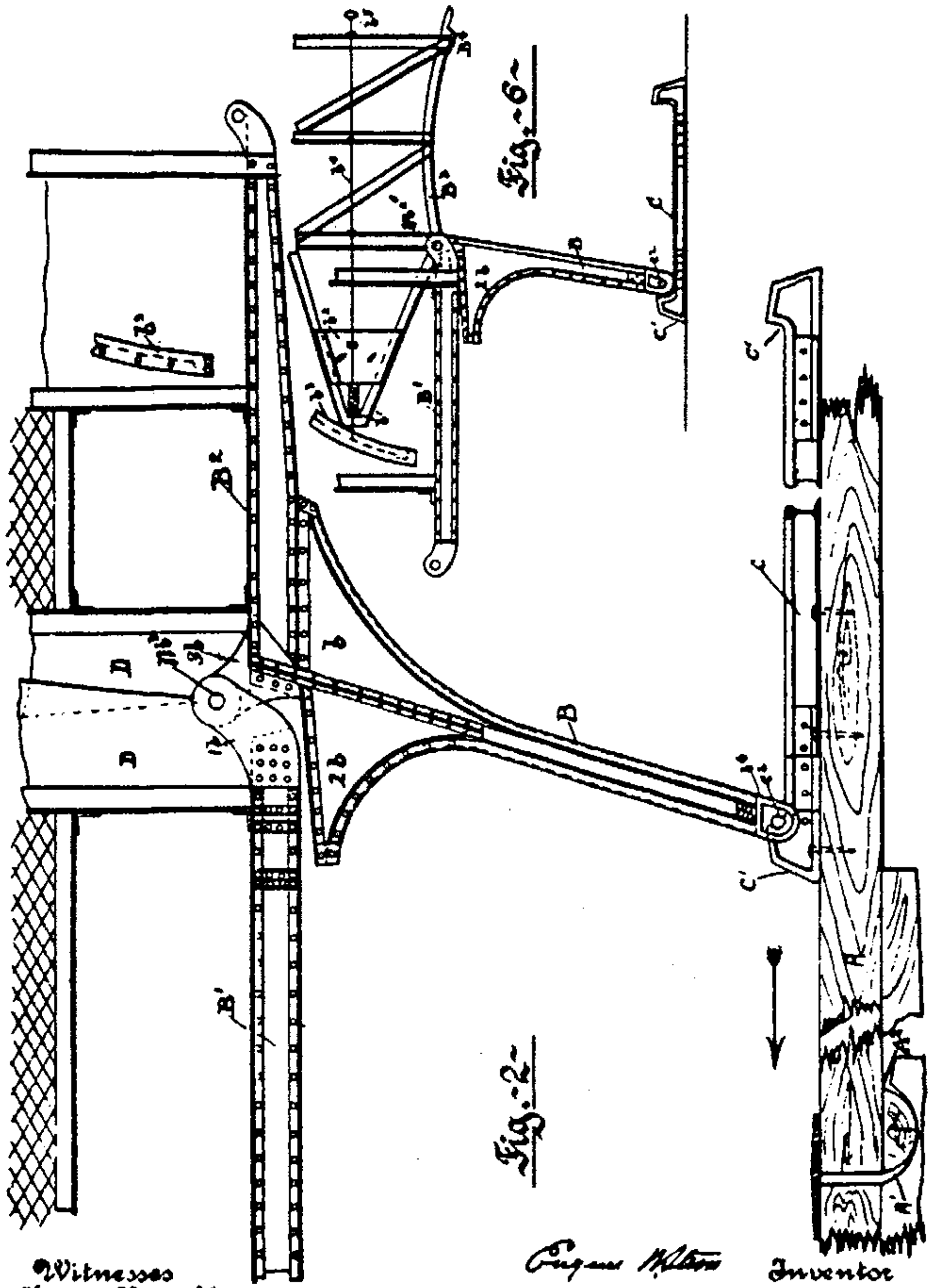

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APPLICATION FILED JULY 19, 1906.

5 SHEETS—SHEET 3.

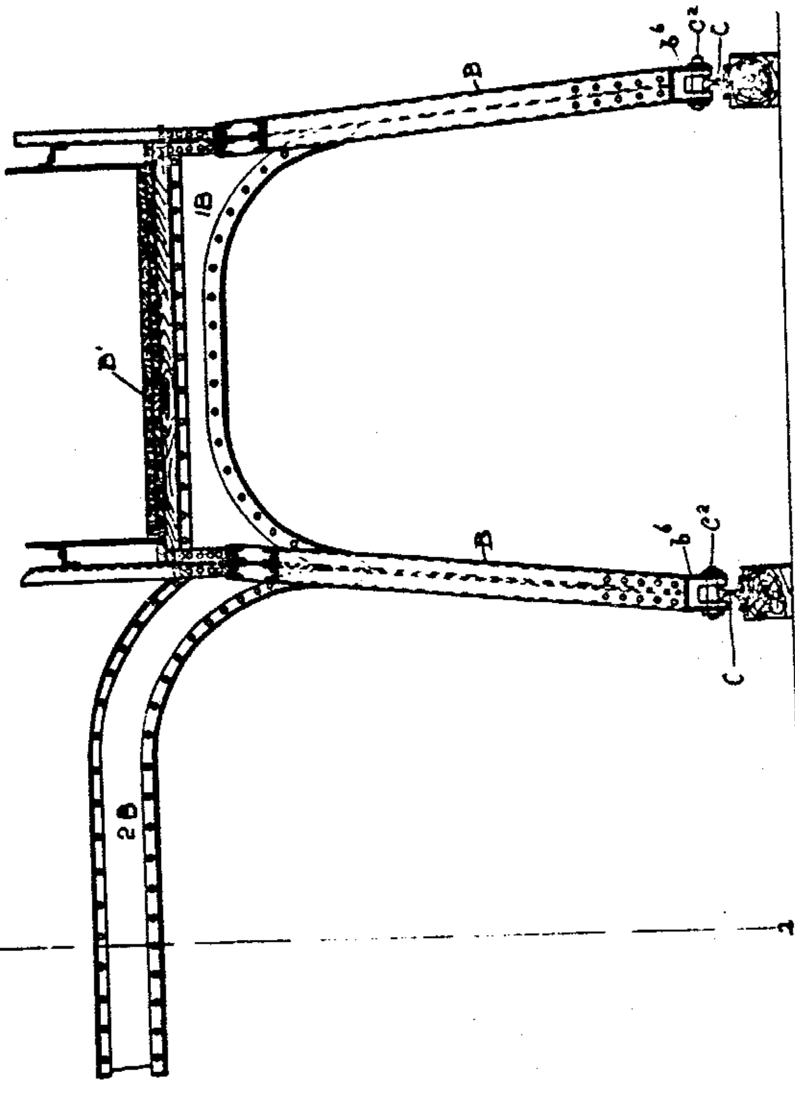

Fig. 3.

Witnesses

Inventor

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No. 848,862. PATENTED APR. 2, 1907.

E. W. STERN.

FERRY BRIDGE.

APPLICATION FILED JULY 19, 1906.

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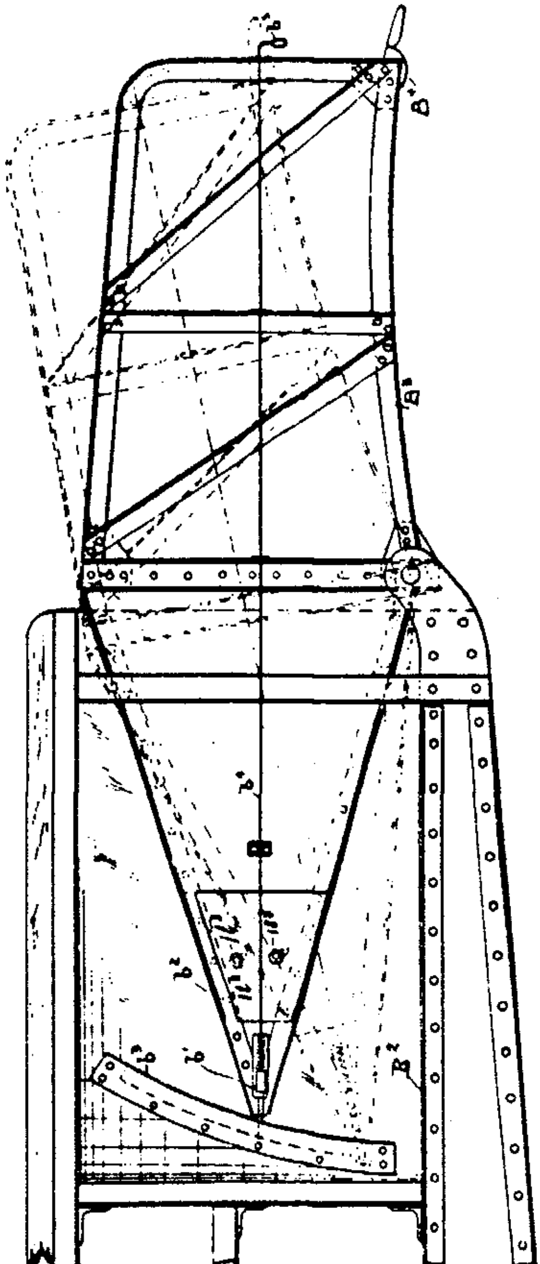

Fig. 4.

Witnesses
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No. 848,882. PATENTED APR. 2, 1907.

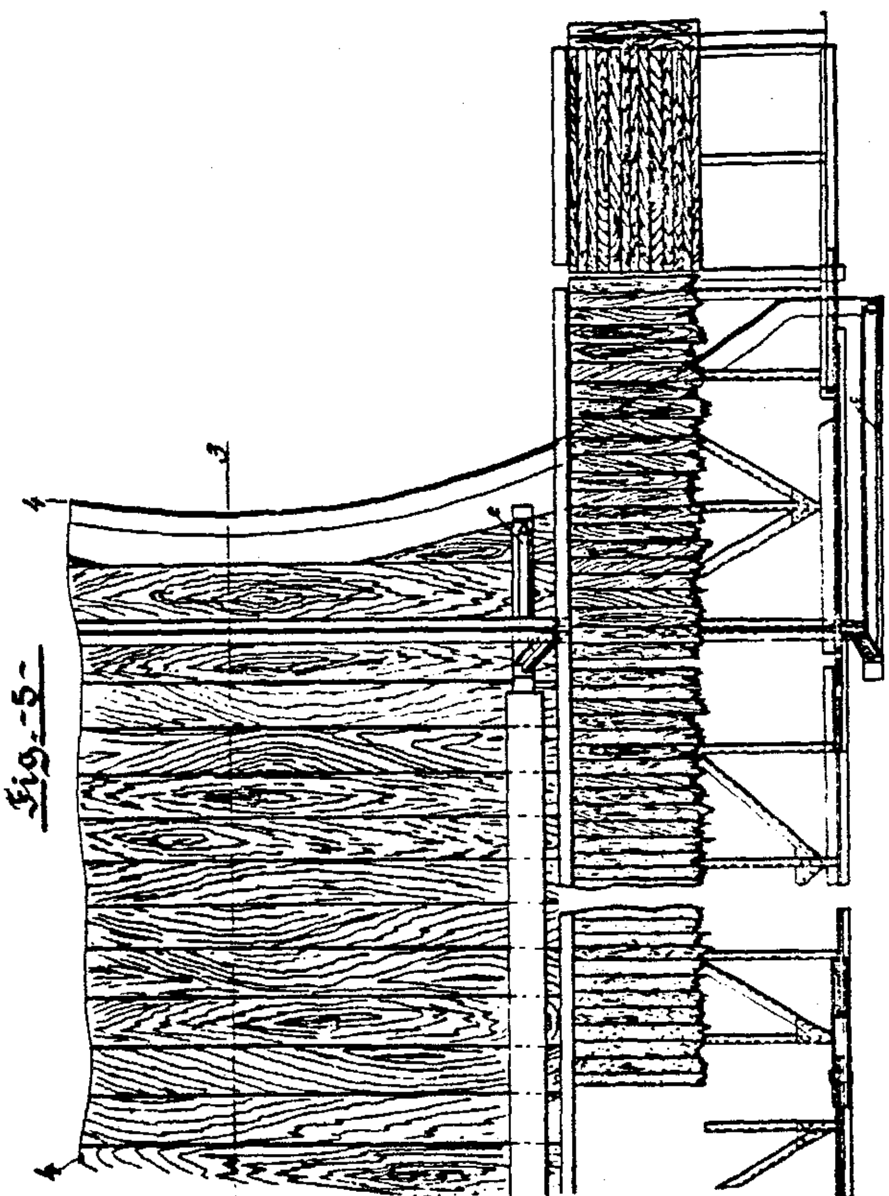
E. W. STERN.

FERRY BRIDGE.

APPLICATION FILED JULY 18, 1906.

6 SHEETS—SHEET 6.

Fig. 5.



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UNITED STATES PATENT OFFICE.

EUGENE W. STERN, OF NEW YORK, N. Y.

FERRY-BRIDGE.

No. 848,862. Specification of Letters Patent. Patented April 2, 1907.

Application filed July 19, 1906. Serial No. 326,811.

To all whom it may concern:

Be it known that I, EUGENE W. STERN, residing in the city of New York, in the county and State of New York, have invented certain new and useful Improvements in Ferry-Bridges, of which the following is a specification.

My invention in ferry-bridges relates to the double-decked type disposed as a slip for the delivery to and the receiving of the discharge from a boat or other similar marine vessel when the same is at its landing position and to that class adapted to be adjusted to register both with the lower and an upper deck of the vessel.

Hitherto and previous to my invention, in so far as I am at present aware, bridges of this character were employed mainly as the slips for making ferry-boat landings and were provided with means for independently adjusting the upper-deck gang-plank to the gangway of the ferry-boat when the same is landed, the lower deck being in some instances adjusted by means of a float or caisson for tide or like variations and by mechanical means for variations in level demanded by the loaded condition of the boat with which the terminal gang-plank of the slip is adapted to register, and in other instances adjustment of the slip has in this connection been effected entirely by mechanical devices. By either of these methods of adjustment it has been customary in practice to employ an attendant to adjust the upper-deck gangway independently to properly register with the corresponding deck of the boat, thus entailing an expense for the services of such attendant, as well as a risk through liability of failure on the part of the employee to properly perform the requirements at all times in the establishing of the requisite register of the upper-deck-gang-plank terminal and the corresponding part of the boat in order to avoid danger arising from collision between these parts.

It is the object of my invention to provide a more effective and inexpensive means for adjusting the terminals of both the upper and lower decks of slips or bridges of this character than by those in vogue and previous to my invention, in so far as I am at present aware, and as well to provide safeguards for the upper decks of these bridges when the same are by inadvertence or accident rammed by the vessel when making a landing or within limits otherwise displaced from the stations or structures to which they are connected.

A feature of my invention is characterized by the novel provision of supporting-columns for the upper deck, bridge, or slip, which is carried by the main-deck bridge and is adapted to provide substantially a parallel movement for these two decks as the system comprising the two is caused to rise and fall by the action of the tide or by a mechanical adjustment for bringing the terminal into register with the corresponding planes of the vessel or boat.

Another feature of my invention lies in the safeguard provision for the upper deck of the bridge structure when the main deck of the same is displaced by collision with the boat or otherwise, as aforesaid.

I attain these objects by the construction as illustrated in the several sheets of drawings hereto attached and the detailed description thereof, which together form part of this specification.

With reference to the drawings, Figure 1 is a vertical longitudinal sectional elevational view of a ferry house or station, illustrating in side elevation my improved double-decked ferry bridge or slip, the upper and lower decks of which are shown in register with a double-decked ferry-boat. Fig. 2 is an enlarged detail side elevational view of an upper-deck-supporting column carrying an outer terminal of the swinging section of the upper deck and the upper-deck terminal slip and a fragmentary side elevational view of its base-support. Fig. 3 is an end elevational view of one pair of the said supporting-columns disposed in the manner of an arch and a transverse sectional view of the upper deck of the aforesaid slip and a fragment of a truss secured thereto and adapted to secure another and similar pair of the said supporting-columns situated to the left of the center line 2 2 and a cross-sectional view of the base-supports for the columns. Fig. 4 is an enlarged side elevational view of the terminal gang-plank for the upper deck and a fragmentary view of the terminal slip to which the same is connected, illustrating two different positions of adjustment for the said gang-plank and means whereby the same is adapted to be controlled by an attendant on the boat. Fig. 5 is a top plan view of the lower and upper deck of approximately one-

It will be observed by the plan, Fig. 5, that a pair of these rails for either side of the structure vary in length more or less, according to the formation of the slip-terminal. In the instance illustrated, wherein the slip-terminal is formed in the manner of a concaved arc, the rail nearest the center line 33 is somewhat shorter than the outer rail, and the effect of this variation in length upon the superstructure when the slip is rammed by a ferry-boat will be more fully hereinafter explained. The deck B' at its shore end or slip end is horizontally swung from and carried by the upper floor projections or galleries 1 B' of the ferry-house by means of the lugs 11 *b* and 11 *b'* and the bearing-pin 11 *b*², and the opposite extremity of the same is pivotally connected to the gangway B² in a similar manner, as clearly indicated in Figs. 1 and 2.

In considering the effect of a longitudinal displacement of the slip or bridge A such, for example, as might be occasioned by the collision of a ferry-boat therewith which would dislocate the joint A' A² and force the slip A in the direction of the indicating-arrow, Fig. 2, over the roadway or shore, the column B being secured by its head to the gangway B² would be substantially retained by the load imposed thereon by the deck, comprising the members B' B² and the jamb 2 *b* of the head *b*, while the rails C, together with the slip or bridge A, would move in the direction of the arrow as aforesaid, when the supporting-pins C² would be forced to slide over the surface or tread of the rail C, while the columns B retain their normal position supporting the deck. In the event of a displacement of the slip being to an extent sufficient to sever the connection between the inner columns, or those toward the center line 2 2 of Fig. 3, and the outer terminal of the rail C the center structure would then be supported by the columns B and the outer rail C and by the girders 1 B and 2 B, and thus relieve the deck of a disastrous wrenching strain which would have been occasioned by the collision had the columns been restricted against movement at their base, thus obviating the wrecking and falling of the superstructure. Obviously, were the bases of the columns secured to the slip A in lieu of being mounted slidingly, in accordance with my invention, the longitudinal displacement of the slip would tend to critically divert the angle of the superstructure and precipitate the occupants thereof or wrench the columns from their fastenings, contributing to the wrecking of the deck.

It will be observed by Fig. 3 that the construction at the base of the columns B provides for a lateral movement or side swing for the slip or bridge A between the limits of the lugs *b*⁶ independently of any movement on the part of the superstructure or deck aforesaid. At the several jointed portions of the deck it will be observed I have provided a means for maintaining the fencing in of the gangway laterally at the joints or hinged connections 11 *b*, 11 *b'*, and 11 *b'*, and for this purpose have overlapped the walls D and D', as depicted more clearly in Fig. 2, in a manner so as to provide a continuity of lateral guard throughout the range of angular movement of the gangway B² with relation to the remaining portion of the deck B'.

I have previously herein referred to the superstructure or deck, indicating the same as the deck B', the gangway B², and the gang-plank B⁴. I desire these parts, however, to be interpreted as the deck when taken together or the superstructure of the double-decked ferry bridge or slip described. In practice I prefer to construct the columns and deck-frames of steel structural forms, securing the elements thereof by riveting or bolting them in a well-known manner. Obviously, however, the structure may be of wood or other suitable material.

In the modification illustrated in Fig. 6 the columns B in lieu of being secured to the gangway B² are swung directly from the deck B', and the gang-plank B⁴ is swung upon the same axis. This construction is particularly applicable in making ferry-boat landings when the upper-deck terminal of the ferry-boat recedes but comparatively little with respect to the lower-deck terminal or when these are substantially vertically over each other.

I am aware that previous to my invention double-decked ferry-bridges have been in vogue, and I am also aware that these have been constructed in a manner whereby the terminals of both the main deck or slip and the upper deck were adjustable for different levels.

It will be observed by the foregoing description that my improved double-decked ferry-bridge provides a means whereby the adjustment of the upper deck, or, as I have termed it, the "deck," is effected by and through the adjustment of the lower deck or slip with which it is connected, while the connection between the upper and lower deck permits of relative transverse and longitudinal movement therebetween, and that the adjustment when effected, irrespective of the water-level or the boat-level due to load, will be such as to establish a register substantially in plane and alinement with the upper deck of the boat automatically by and through the adjustment of the lower deck of the slip with the boat-deck. It will likewise be observed that the head of the column B is provided with an inwardly-overhanging portion or jamb 2 *b*. The jamb 2 *b* when the main deck is rammed by a ferry-boat is brought into contact with the under side of the upper deck B', which in consequence of the load imposed upon the column B through half of the structure, omitting the columns—to wit, to the right of the line 3 3. The remainder of the structure is indicated as being broken away at the irregular line 4 4. Fig. 6 is a modificational detail view illustrating another form of one of the supporting-columns in accordance with my invention and the adjustable gang-plank connected therewith, and Fig. 7 is a fragmentary detailed view of the upper-deck displacement-supporting members.

In the several figures similar characters of reference indicate identical parts, wherein—

A depicts a swinging slip or ferry-bridge of well-known construction, adapted to swing on a horizontal stationary axis comprising a semicylindrical bearing-socket A' and corresponding rocker A^2, as illustrated fragmentarily in Fig. 2. The socket A' is usually constructed of wood and is carried by the piling or other suitable construction at the shore of the landing. The rocker A^2 being constructed of similar material is bolted or otherwise secured to the under side of the slip structure. The outer extremity or terminal of the slip A is in some instances buoyed up by the water through the agency of a caisson or float A^3 secured thereto. It has also been customary in practice to support this extremity from preferably the roof of the ferry-house through the agency of an adjustable counterbalancing-chain A^4 or other tension member and again by both the suspension-chain A^4 and counterbalancing-weights A^5 and the caisson A^3. The latter in this instance carries the greater part of the load upon the free end of the slip A, while the suspension-chain A^4 and counterbalance A^5, together with a suitable capstan A^6, provide a means for effecting variations in the level of the free terminal of the slip in accordance with the variations in the draft of the boat with which the slip is to register under varying loads.

Carried by the terminal of the slip or bridge A and substantially at points within a line in which the same is supported are the deck-columns B. In the instance illustrated two of these are shown in Fig. 3 supporting a deck B' and a gangway B^2, pivotally secured thereto. The two columns B, carrying the deck, are connected together in the manner of an arch by a girder 1 B. A pair of these columns, together with the deck B', are provided for respectively the starboard and port side of ferry-boats having longitudinal lateral cabins over bilges and are connected together by a truss 2 B in a manner well known to those skilled in the art to which my invention relates.

The gangway B^2 is fixed securely to the heads b of the columns and by its kinematic relation with the column, slip, and deck is adapted to assume substantially a horizontal position as the structure comprising the slip and deck is lowered or raised in the effecting of an adjustment of the structure to the level of the boat, as aforesaid.

Carried by the free end of the gangway B^2 is a terminal bridge or gang-plank B^3, which is pivotally secured to the terminals of the gangway in a manner whereby the said gang-plank may be swung vertically into either of the positions as illustrated in Fig. 4, in which positions it is secured by means of a spring-actuated latch b', carried by the free terminals of the framework b^2 of the gang-plank B^3 and the segmental notched latch-plate b^3, as clearly illustrated in Fig. 4. The latch b' is adapted to be controlled by an attendant on the boat through the agency of preferably a pull-rod b^4 and handle b^5. The gang-plank B^3 terminates at its outer extremity in a swinging floor-sill B^4. To effect a counterbalance of the gang-plank B^3, I provide an adjustable counterbalancing-weight 1 b^3, which may be fixed in an adjusted position by the bolts 1 b^3.

In considering the question of hazard to the passengers upon automatically-adjustable deck ferry slips or bridges of the character to which my invention relates in the event of accident to the fundamental structure carrying the deck, my attention has been directed to the necessity of permitting freedom of motion within certain limits of the displacement of the slip when rammed by a ferry-boat, and regarding public safety as an object in this connection I provide what I believe to be of considerable importance in the construction of ferry-bridges of the character aforesaid, and the manner by which I obtain this object of my invention is to provide for the supporting-columns B a base comprising the rails C and the socketed terminals C^2 therefor, permitting longitudinal displacement of the slip A with respect to the deck comprising the members B' and B^2 aforesaid. These rails are preferably of the usual standard type employed in railway service and may be of a length in proportion to the structure approximately as that illustrated in Figs. 1 and 2 and varying in cross-sectional dimensions in proportion to the requirements of load to which they are to be subjected. The socketed terminals C^2 preferably consist of steel castings secured to the rail and united by means of angle-bars or fish-plates, as clearly illustrated in Fig. 2, the socket being presented with respect to the base of the columns B as a thrust-bearing and back-stop. The lower extremities of the columns B are provided with lugs b^6, carrying bearing-pins C^3, which ride upon the rails C, as illustrated in Figs. 2 and 3. The rails C are secured to the floor of the slip or bridge in a well-known manner by spikes or bridge-bolts, preferably the latter, and in such a manner as to restrict the rails C against movement.

the deck B′ restricts the column B to a limited angular movement. The clearance between the jamb 2 *b* and the deck B′ provides for the normal amount of play which is required between these two members as the structure plays vertically during its adjustment by the action of the tide or otherwise, as aforesaid. In the event, however, of the longitudinal displacement of the fundamental structure tending to move the base of the columns toward the shore of the structure the jamb 2 *b* will be brought into contact, as aforesaid, with the under side of the deck B′, and thus prevent the gangway B² from dipping to a critical angle. This will cause the base-support of the column B to slide forward along the rail C.

In the event of a displacement of the slip A of greater extent than the length of the rails C the outer stop C′ would be brought into contact with the base support or pin C² of the column B, and when the movement is in excess of this length the angular position of the column B would be beyond the critical position for properly supporting the gangway B², and the jamb 2 *b* being still in contact with the under side of the deck B′ would be in a position upon further displacement, as aforesaid, to become wrecked. To obviate the wrecking of the superstructure, I provide the ways d^3 and the slotted bearing d^4 for the lug 4 *b* in lieu of the circular perforation therefor, thus permitting the entire superstructure to be lifted by the jamb 2 *b*, thereby enabling the bearings 11 b^3 to skid up the ways d^3.

Having fully described my invention, I claim as new and desire to secure by Letters Patent of the United States—

1. In a double-decked ferry-bridge, the combination with the main deck of a superstructure and interposed column-supports and a longitudinal sliding base therefor.

2. In a double-decked ferry-bridge, the combination with the main deck of a superstructure comprising a second deck and interposed column-supports, and a longitudinal sliding base therefor provided with terminal stops.

3. In a bridge of the character described, a fundamental swinging structure having substantially a horizontal fixed axis, a jointed superstructure carried by the fundamental structure, the two adapted to swing in unison, supports for the superstructure pivotally connected thereto and slidingly connected with the fundamental structure.

4. In a bridge of the character described, the combination of a fundamental structure and a superstructure, both being adapted to swing on fixed substantially horizontal axes, and of supports, for the superstructure carried by the fundamental structure, provided with a sliding base connection.

5. In a plural-decked bridge of the character described, and wherein the same is adapted to swing on substantially horizontal fixed axes, a column-support having a sliding base rising from the main deck and pivotally connected with the upper deck, a gangway for the upper deck carried by said support and adapted to maintain a substantially horizontal position during the range of swinging movement on the said bridge, substantially as described.

6. In a plural-decked bridge of the character described, having a main deck and an upper deck substantially vertically over the former, adapted to swing on substantially horizontal fixed axes, a column-support having a sliding base rising from the main deck and pivotally connected with the upper deck, a gangway for the upper deck carried by said support, a stationary support for the structure, and means connecting the free swinging terminal of the lower deck and said stationary support for adjusting the horizontal position of said gangway.

7. In a bridge of the character described, the pivoted gang-plank provided with an adjustable counterbalance, and means at the outer terminal of said gang-plank for securing the position of the gangway.

8. In a bridge of the character described, the pivoted gangway provided with an adjustable counterbalance and a latch at the inner extremity, and a swinging sill at the outer extremity thereof together with means at the outer extremity of the gangway for controlling the latch.

9. In a gangway, a pivoted terminal gang-plank, a counterbalance and a latch at one extremity of said gang-plank, and means at the outer extremity of said gang-plank for controlling the latch.

10. In a double-decked bridge of the character described, the combination of upper-deck supports and longitudinal-displacement bases therefor of varying lengths.

11. In a double-decked bridge of the character described, the combination of upper-deck supports and longitudinal-displacement bases therefor of varying lengths, and of a truss structure for receiving the stress imposed upon the deck when the shorter-length bases have been displaced.

12. In a double-decked bridge of the character described, the combination of upper-deck supports and longitudinal-displacement bases therefor of varying lengths, the upper-deck supports being provided with longitudinal-displacement bases and of a truss structure.

13. In a double-decked bridge, the combination of upper-deck supports and longitudinal-displacement bases therefor said upper-deck supports being provided with means for restricting the movement of the supports.

14. In a bridge of the character described and in combination with the superstructure, **supporting-columns** having longitudinal-displacement bases, the heads of the supporting-columns being provided with stops.

15. In a bridge of the character described and in combination with the superstructure **and column-supports** therefor, displacement-**supporting bearings** for the superstructure and longitudinal-displacement bases for the supports.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

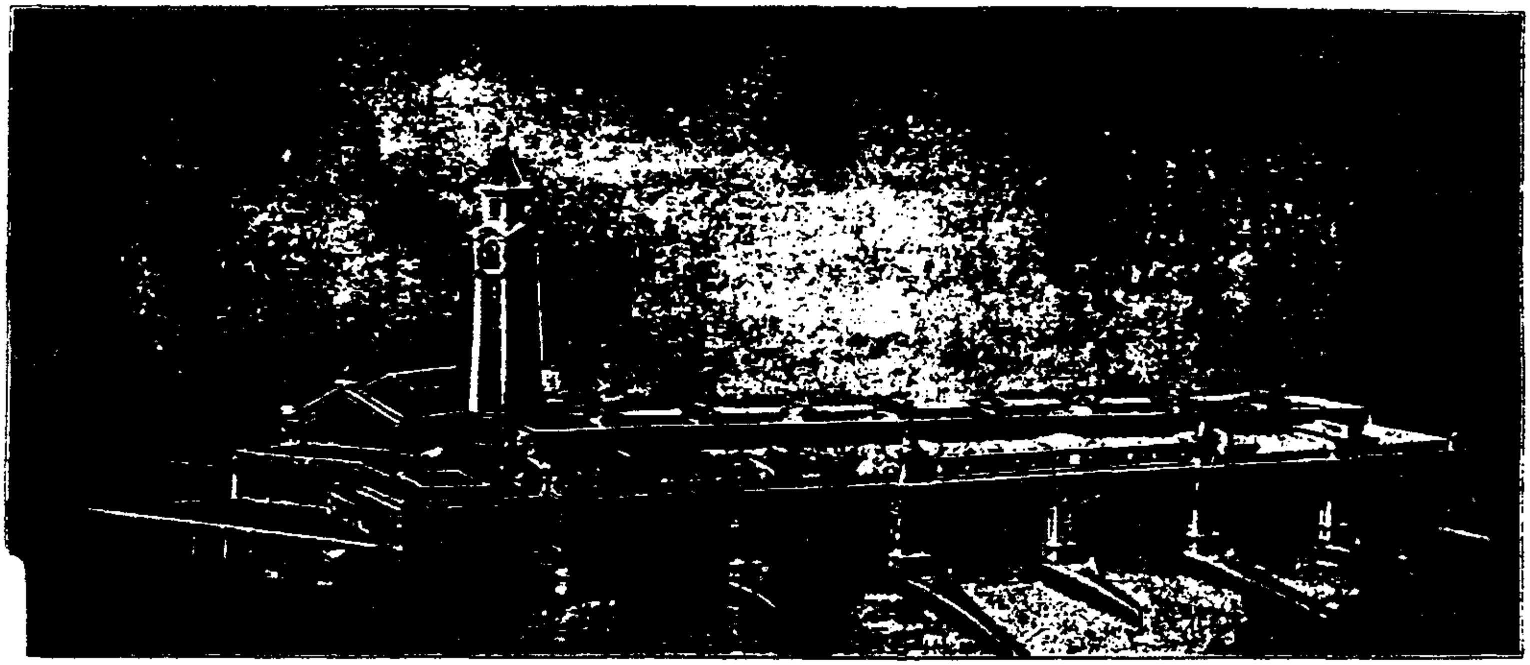
EUGENE W. STERN.

Witnesses:
R. YOUNG,
SOLON HERZIG.

THE NEW TERMINAL STATION AND FERRYHOUSE OF THE DELAWARE, LACKAWANNA & WESTERN R. R. AT HOBOKEN, N. J.

By Charles C. Hurlbut.*

The new terminal and ferryhouse of the Lackawanna Railroad at Hoboken, N. J., now in course of construction, is a fireproof structure erected entirely over water and possesses some features unique in buildings of this class. The architectural effect of the new terminal may be gathered from the adjoining halftone



GENERAL VIEW OF NEW TERMINAL OF DELAWARE, LACKAWANNA & WESTERN R. R. AT HOBOKEN, N. J.
(From photograph of a model.)

..w, the photograph of a complete model of the structure; the view is from the southeast, thus showing the ferry front of the building.

The chief points of interest from an engineering and architectural standpoint are the concrete foundation supported on piles; the steel and concrete construction of the superstructure, designed with a special view to the resistance to shock and unequal settlement; the very extensive use of copper as an exterior finish and its mode of application, and the methods of erection necessitated by the conditions of traffic.

GENERAL PLAN.

The plan was controlled to a large extent by local conditions. About 600 ft. of the water front was available, bounded on the north by the steamship piers of the Hamburg American Line. As a large part of this frontage was occupied by the old terminal, through which abou: 1[illegible]0 people a day were passing, it was necessary to design the new building for construction in six consecutive sections, each of which could be opened for traffic before starting the succeeding one. A fire on Aug. 8, 1905, which totally destroyed the old terminal and ferryhouse, somewhat altered this plan, however, and the temporary buildings now in use were so placed as to facilitate the construction as far as possible. An elevated-track station was considered but rejected as impracticable owing largely to the steep grades that would be introduced by the position of the railroad yards and the tunnel through Bergen Hill, only a short distance away.

The number of passengers carried by the three ferries entering the terminal in the first six months of 1906 was 17,200,000, which means a daily average of 94,500. As the number carried on Sundays and holidays, however, is much less than on week-days, the week-day average is something over 100,000. Of this number something less than half are railway passengers, and the others are distributed by the trolley lines terminating at the station or pass direct to the street. The great bulk of this traffic is concentrated into a few hours in the morning and late afternoon. The ferryhouse provides for three separate ferry-lines, each with two slips, equipped for double-deck boats. To separate and prevent congestion of these many lines of traffic, to provide for rapid loading and unloading of boats, to make the entrance and exit of ferry-passengers as short and direct as possible, and (not least) to prevent "beating the ferry" were the main controlling factors in the plan of the ferryhouse portion of the terminal.

The requirements of the railroad station were: Ample waiting-rooms facilities for passengers waiting for trains and for boats, including provision for housing safely as many as 20,000 people at one time, which might become necessary in the event of the disability of the ferry for an hour or more in the morning rush hours; Restaurant, lunch-room and kitchen; Storerooms for the dining car and commissary departments; Offices for the division superintendent, train dispatchers, ferry superintendent, baggage master, auditor and other officials; besides a barber shop, toilets, hospital room and the other usual adjuncts of a terminal railroad station.

The disposition of space to meet these various requirements is clearly shown on the general plans reproduced in Fig. 2. Eastbound passengers from trains pass from the train concourse either (1) up a 10% incline just south of the Main Waiting Room, to the ferry concourse on the second floor and thence to the upper deck of the boats, or (2) through the eastbound waiting-room and team concourse to the lower deck of boats. Subsidiary waiting-rooms are provided on the first floor, for the convenience of passengers, between the ferry slips. Eastbound ferry passengers enter the ferry waiting-room and pass direct to the boats, or by means of stairs to the ferry concourse. Westbound passengers pass direct to the street by practically straight exits from the lower deck of boats; or, from the upper deck, enter the

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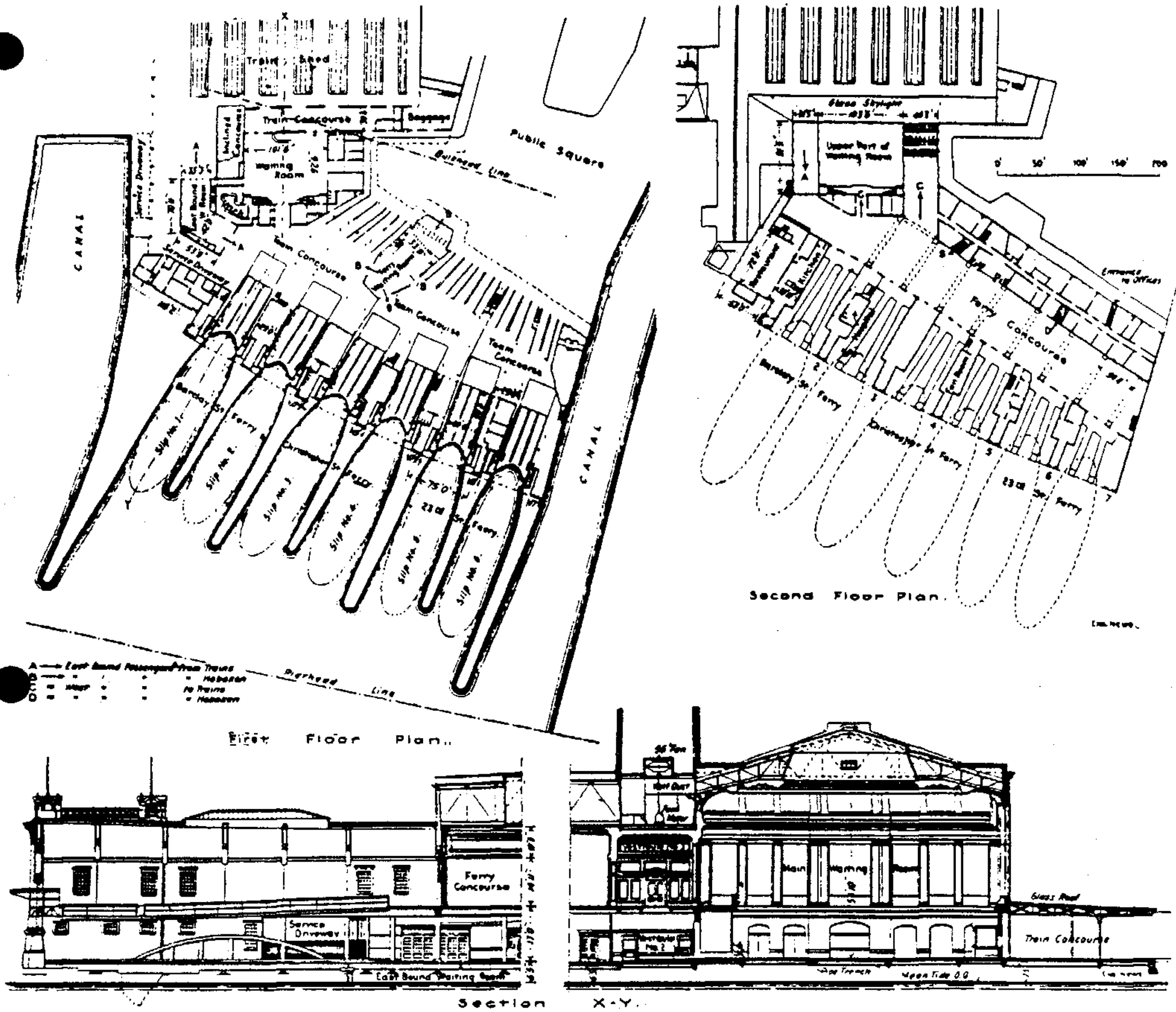


FIG. 2. FIRST AND SECOND FLOOR PLANS, AND LONGITUDINAL SECTION; LACKAWANNA TERMINAL STATION AT HOBOKEN, N. J.
(Note.—Upper Deck Landing Bridge Shown in Longitudinal Section is old type. See Fig. 13 for drawing of bridge actually used.)

ferry concourse, and thence pass to the street by easy stairways. Passengers to the trains go to the trainshed by way of the westbound concourse, which leads off the Ferry Concourse along the north of the main waiting room and terminates in a stairway 40 ft. wide, or pass into the main waiting-room by a marble staircase. Provision is made in the plan for a future arcade from the ferry concourse to the trolley terminus about 200 ft. away.

The main waiting-room for westbound (outgoing) train passengers is 90 ft. x 100 ft. in plan, and 53 ft. 10 ins. high, with large windows on all sides and a large skylight overhead. The ferry concourse is 70 ft. wide, 470 ft. long and ft. 5 ins. high, lighted by large skylights. The concourse is flanked by rows of twin columns supporting deep beams which divide the main part of the concourse into seven panels, forming its most distinctive decorative feature. The restaurant is 72 ft. x 53 ft. The total river elevation is 506 ft. 2½ ins. long. The train concourse is 307 ft. long and provides for fourteen

roof of wire glass supported on steel trusses and purlins. The sidewalk along the entire street front of the building is covered by a marquise of similar construction.

A two-story building to serve as immigrant station and as depot for the supply of Pullman cars is located at the head of the short canal just south of the main terminal. This building is indicated in the Second Floor Plan (in Fig. 2). The Service Driveway and the Immigrant Track are arranged with reference to the location of this building.

Structural and Ornamental Design.

GRADES.—The floor level of the ferryhouse was fixed by the height of the first deck of the boats above the water under ordinary loading, namely 6 ft. 5 ins., and that level was therefore adopted as the general level of the ferryhouse floor. The level of the railroad station was determined by the height of the tracks, and that floor was accordingly fixed at 7 ft. 5 ins. above mean tide. The change from one grade to another is made by easy inclines. The level of the tops of piers

from the river is the clock tower, which rises to a height of 203 ft. above mean tide to the base of the flagpole. The six ferry slips are spanned by arches, supported by ornamental piers, as shown in the view on the preceding page. The base of the piers and also the base of the restaurant wing is of faced concrete; above this level the entire structure, including the tower, is covered with copper-work. The west or street elevation of the ferryhouse portico has five bays, surmounted by pediments, and is also of copper. The baggage room building and the first story of the north elevation of the railroad station are of Indiana limestone with copper-work above. The ornamental details of the copper-work were carefully studied with a view to preserve the character of the material and give a "metallic feeling" to the design. Details and moldings usual in stonework cannot be copied successfully in sheet-metal without modification, and all appearance of an attempt to imitate stone or other material was carefully avoided. The interiors will be finished for the

... is built over water of a depth of about ... overlying from 70 to 75 ft. of mud. Under the mud is a bed of sand and gravel of varying thickness, and rock is encountered at a depth of from 110 to 120 ft. below mean tide. The general requirements of the case called for a permanent, fireproof structure, sufficiently flexible to permit of slight inequality of settlement without serious damage and yet sufficiently rigid to withstand the shocks of the ferryboats, and as light as possible. The type decided upon was a riveted steel framework enclosed entirely in concrete. All the stresses are figured as taken up by the steel.

FOUNDATIONS.—The typical foundation is clearly shown in the vertical section in Fig. 3. Each column is supported on a group of from 9 to 25 piles of long leaf yellow pine from 80 to 90 ft. long. The pile loading is about 8 tons maximum. The piles are cut off at low water and capped with 12 × 12-in. timbers, upon which is laid a solid flooring of 12 × 12-in. alternating with 12 × 8-in. timbers. As the average height of tide (between high and low water) is 5 ft., the woodwork is entirely submerged about two-thirds of the time and is always wet, so that the danger of decay is eliminated. In the waters of the North River it is unnecessary to take precautions against the teredo or limnoria, as the presence of these pests has not been discovered in any piles driven in these waters within the last twenty years. This statement is based on the experience of the engineering departments of the Delaware, Lackawanna & Western R. R. and the New York City Department of Docks & Ferries; the fact is explained by the presence of sewage in the water. In each grillage as described above, two or more timbers of each co... are continuous through two or more footings, as shown in the plan in Fig. 3. The footings are therefore securely tied together in two directions, effectually preventing any lateral displacement of any individual footing. The whole

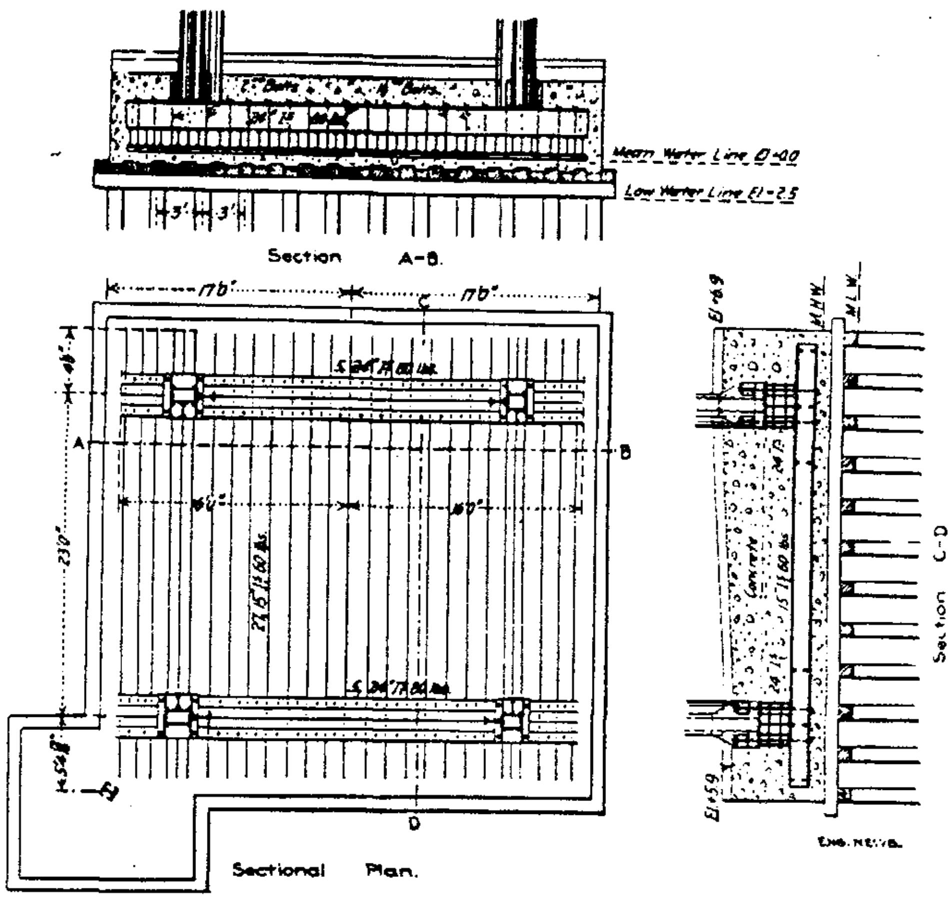
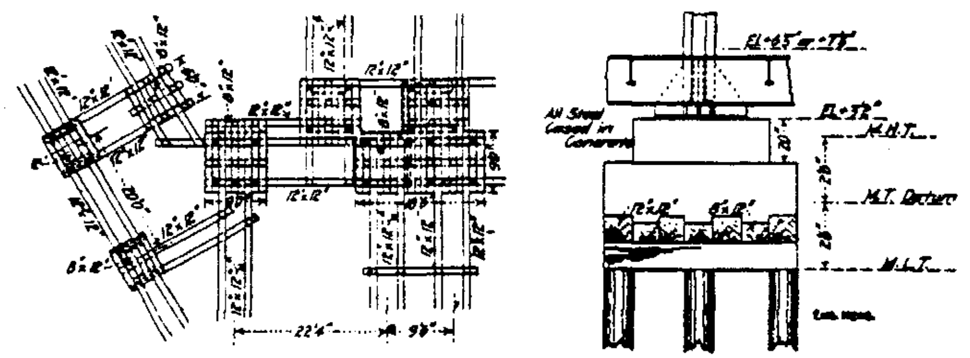


FIG. 4. FOUNDATION OF TOWER.



Piling and Grillage. Column Foundation.

FIG. 3. TYPICAL COLUMN FOUNDATION, AND PART PLAN OF PILING AND GRILLAGE, SHOWING METHOD OF TYING TOGETHER THE PIERS.

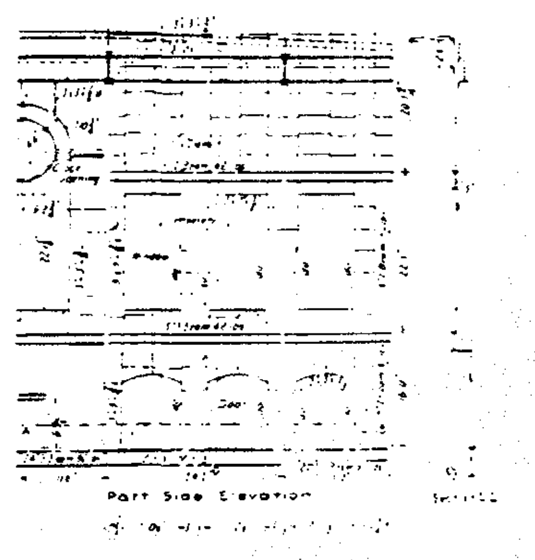
imber structure is securely bolted together. On he platforms described were built concrete piers vhich were leveled off for the columns 3.15 ft. .bove mean tide. Anchor bolts were built in to ecure the columns, and under the heavier col- :mns the concrete piers were reinforced with rillage of steel beams.

The foundation of the tower, Fig. 4, differs rom this arrangement because the tower was lesigned to rest on a single foundation block in lece of four separate footings, in order to avoid ... of unequal settlement. The area covered y ... tower foundation is closely piled and a wo-course timber grillage built over the piles. 'he concrete pier constructed on this grillage xtends to within 4 ins. of the finished floor, or ft 1 in. above mean tide; it encloses a steel rillage of two courses of I-beams, 15 and 24-in., ecurely tied together by steel angles and bolts. 'he four tower legs rest on the upper course

case of undue settlement; for the same purpose inverted stiffeners were placed above the girder connections of the first floor, strong enough to take the entire dead load of the column above the first floor, except where the girder connection itself was strong enough to take this load. After placing the steelwork of the first section the column footings settled about ¾-in., and after the concrete of walls, floors and roof was placed a further settlement was found, ranging from ¼-in. to 2¼ ins. The tower foundations settled ¾-in. after placing the concrete pier; this was taken up with steel plates before setting the steelwork. After the erection of the steelwork a further settlement of ⅞-in. was found, uniform over the whole area of the tower base.

The general type of the foundations was developed by the writer, with the cooperation of Mr. E. W. Stern, the consulting engineer of the work. The pile loading was fixed by the engi-

crete, Columbian type, supported on steel beams and girders with riveted connections. The beams are spaced from 5 ft. to 7 ft. on centers. The first floor is of stone concrete and the second floor and roof are of cinder concrete, both being mixed in the proportion 1:2½:5. The first floor of the ferryhouse and the service driveway are designed for a maximum concentrated load consisting of a truck weighing 15 tons on a 5 ft. × 10 ft. base. Other floors are designed for live loads of from 90 to 120 lbs. per sq. ft. It will be noted from the drawings that the first-floor girders are riveted to the columns and do not rest on the concrete footings, and as stated above these connections are in all cases made



Part Side Elevation

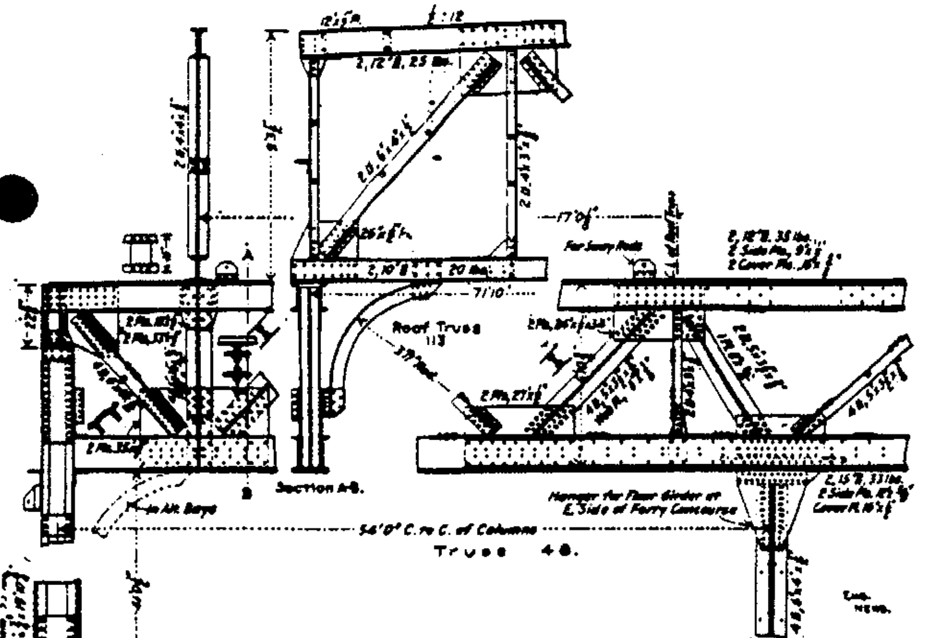
...nt to support the dead weight on the ...

WALLS.—The outside walls and the walls of ...e ferry slips and team concourse are 5 ins. ...ick. of cinder concrete reinforced with ver...al 3-in. I-beams about 4 ft. on centers, which ...e bolted at the top and bottom to wall beams ...d are stiffened with frequent tie rods. Fig. 5 ...ves an idea of how this metal studding is ...ranged in the case of one of the large un...

is entirely incased in concrete. The main roof trusses are protected from fire by suspended ceilings plastered with Portland cement mortar.

Fig. 6-a, giving a part plan of the framing, illustrates the general arrangement of the steelwork. A noticeable feature of the steel framework is the method of connection and bracing of trusses and girders. As stated above some irregularity of settlement must be looked for in a building of this area, and for that reason

FIG. 6A. PART PLAN OF ROOF FRAMING OVER FERRY SLIPS AND FERRY CONCOURSE.



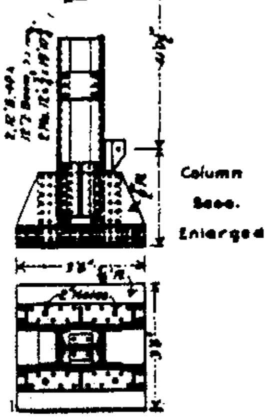


FIG. 6B. ROOF TRUSS OVER FERRY CONCOURSE AND LONGITUDINAL TRUSS BETWEEN FERRY SLIPS AND CONCOURSE.

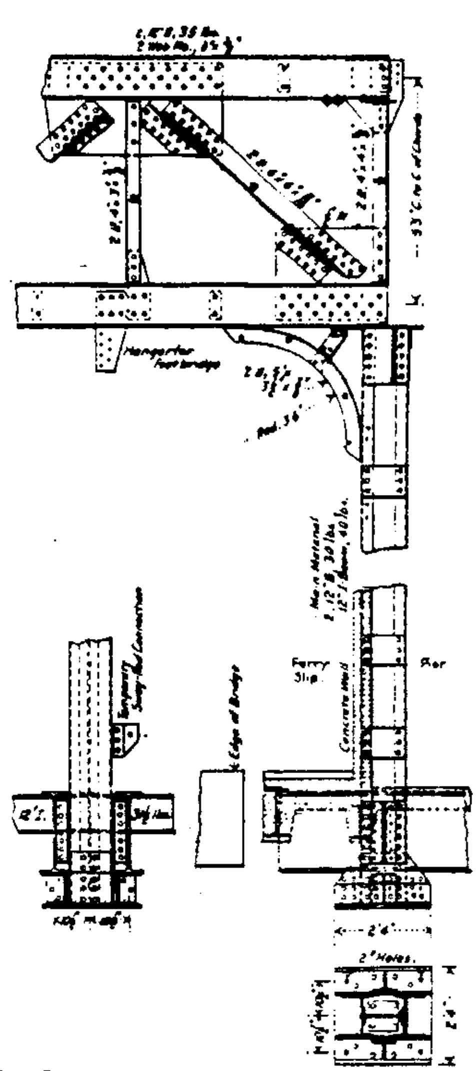


Fig. 7. Part Transverse Section of One of the Ferry Slips, Showing Steel Framing.

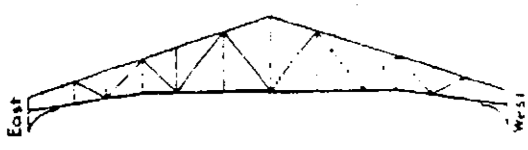
...fened walls. All openings are framed out with ...le irons or 5-in. channels. The concrete bases ...ver piers and the base of the restaurant ...nsist of faced stone concrete and are con...rably thicker. All the cinder-concrete walls ...covered with sheet metal which is secured to ...concrete by bolts passing entirely through the ...(nailing is not permitted); on outside walls ...is 18-oz. copper, on other walls it is No. 22 ...vanized iron siding of clapboard pattern.

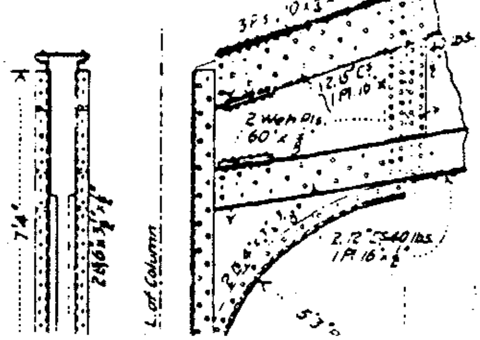
rigid connections were avoided as far as possible. The roof trusses in nearly all cases rest either on the tops of columns or on the top flange of longitudinal girders as illustrated in Figs. 6 and 7. The bracing is effected by heavy curved knee braces which resist as curved beams and not as struts, and will continue to act as braces even after some displacement of steel occurs due to settlement, whereas a rigid connection would be torn apart and fail utterly. The connection of the trusses over the main waiting-room is an exception to this rule (Fig. 8), as these trusses are riveted to the sides of the columns; but the length of the columns in that case is considered to offer sufficient flexibility.

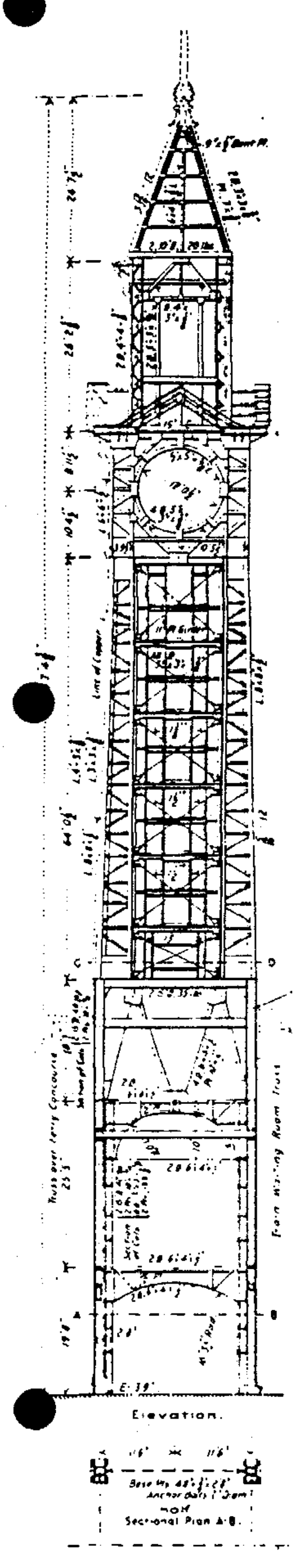
Except in the tower, no diagonal framing is used in the walls, in order to carry out this scheme of flexibility. But abundant provision was made for temporary sway-bracing; connection plates for 1-in. diagonal rods riveted to the columns were provided (see Fig. 7) instead of

The tower, Fig. 9, is a steel skeleton covered with ornamental copper which is reinforced with small angles and bolted to the steelwork. The tower is not enclosed in concrete walls. It contains a clock and a 2,500-lb. bell; otherwise its purposes are purely ornamental. It is separated from the building proper by a concrete floor at the roof level.

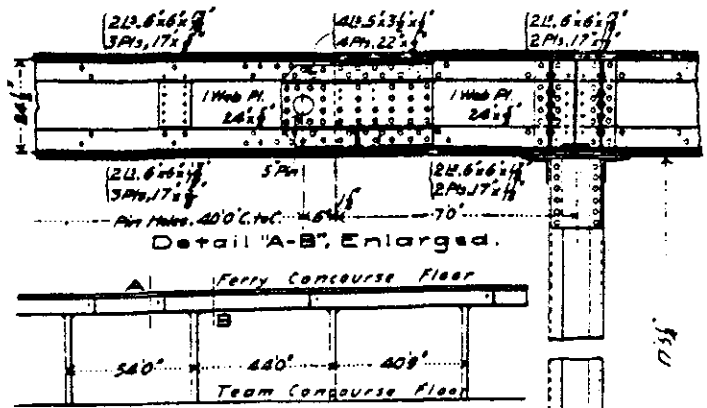
The steelwork of the floors is generally simple. The special connections of the first floor girders







have already been remarked upon. Another feature worth noting occurs in the floor of the ferry-concourse, where long spans had to be bridged, as the team-concourse beneath could not be impeded by columns. Since head-room in the team-concourse was an important matter, it was necessary to contrive girders of the required span with a minimum depth. This was done by using a pin-connected cantilever construction for the main plate-girder which runs longitudinally under the ferry-concourse floor. Fig. 10 shows the construction used. This girder runs along the middle line of the ferry-concourse. The corresponding girders along the east line of the ferry-concourse, which have equally wide column spacing, do not require this unusual device, as they could be hung from the roof trusses above by a suspender, which halves the girder span (see Fig. 6-b).



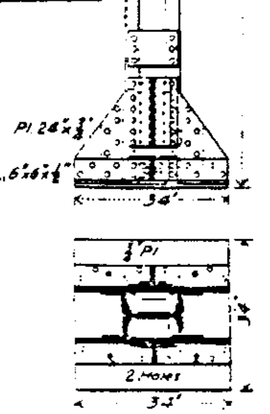


FIG. 10. LONGITUDINAL CANTILEVER GIRDER UNDER FERRY CONCOURSE FLOOR.

FINISHING MATERIALS.

Wood will be used very sparingly throughout the building, being limited to trim and the floors of offices.

FLOORING.—The principal rooms, including main waiting room, ferry waiting room, restaurant, lunch room, kitchen, service room, barber shop and the west bound and main ferry concourses, are floored with terrazzo. In the construction of these floors special attention is given to reducing the danger from cracks to a minimum. The fireproof floor slab finishes 3 ins. from the finished floor. Over this is laid one inch of dry sand, above which is spread a layer of tar paper, and above the paper 2½ ins. of cinder concrete (1:3:6 mix). The top 1½ ins. is a terrazzo wearing surface of cement and Italian marble chips ground and rubbed to a true polished surface. The terrazzo is laid in patterns of various colors determined by the kind of marble used, white and serpentine predominating. These rooms are also provided with marble bases.

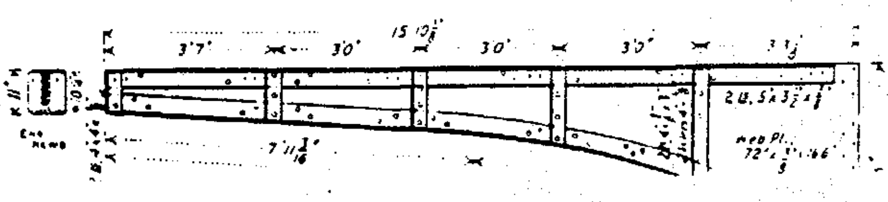
The entire area of the inclined concourse is covered with Mason safety treads set in Portland cement. Provision is made for their removal by setting in cast-iron blocks to which the tread is screwed. The team-concourse, comprising almost the entire first floor of the ferry house, is vitrified brick set in asphalt. This paving was adopted after a thorough investigation by the railroad company of granite, wood and asphalt blocks, sheet asphalt, plank and other floors, and was selected because of its great wearing qualities and freedom from slipperiness. The train-concourse floor and some of the storeroom floors are cement. The east-bound waiting-room and the commissary receiving room have asphalt floors of specially selected rock asphalt. The baggage-room has a rock asphalt floor in which is imbedded a cast-iron grill of hexagonal pattern. All asphalt floors are laid under a five-year guarantee. The ferry waiting-room and the piers between the ferry slips are specified of magnesium composition. All office floors are of maple.

ROOFING.—All flat roofs are five-ply tar and gravel, the tar being best straight run American coal-tar pitch. The roofs are guaranteed for ten years by a security company's bond.

DAMP-PROOFING.—To prevent moisture arising from the river and working through the floors, all enclosed rooms of the first floor are protected with a damp-proof course of three-ply felt and coal-tar pitch laid between the fireproof floor slab and the fill. A similar course is provided under the kitchen and toilets of second story and on the inclined plane.

PARTITIONS.—All partitions are constructed of flat metal studding and wire lath. They are of three types: (A) 2-in. solid plaster with one thickness of lath imbedded; (B) 4-in. hollow partition having 2-in. air space, and (C) partitions similar to B but filled solid with cinder concrete. Type B predominates throughout the job. Type C is used where a partition of extra strength is required, as the walls of concourses or where there is a special fire hazard as in the case of store-rooms.

PLASTERING AND FURRING.—All finished rooms are plastered with three coats of patent plaster applied on galvanized metal lath. The furring bars are in all cases bolted to their supports, the only tying allowed being in the attachment of lath. Suspended ceilings are supported on extra strong bolted hangers. In the case of wall furring, bolts are built into the concrete, to which are secured horizontal 1 x ¼-in. bars 4 ft. c. to c. The ¾-in. channel furring bars, 12 in. c. to c., are bolted to these bars with angle clips and ¼-in. bolts. In the ferry-concourse, the wall furring is divided into separate panels and the joints covered by pilasters, each cast in one piece



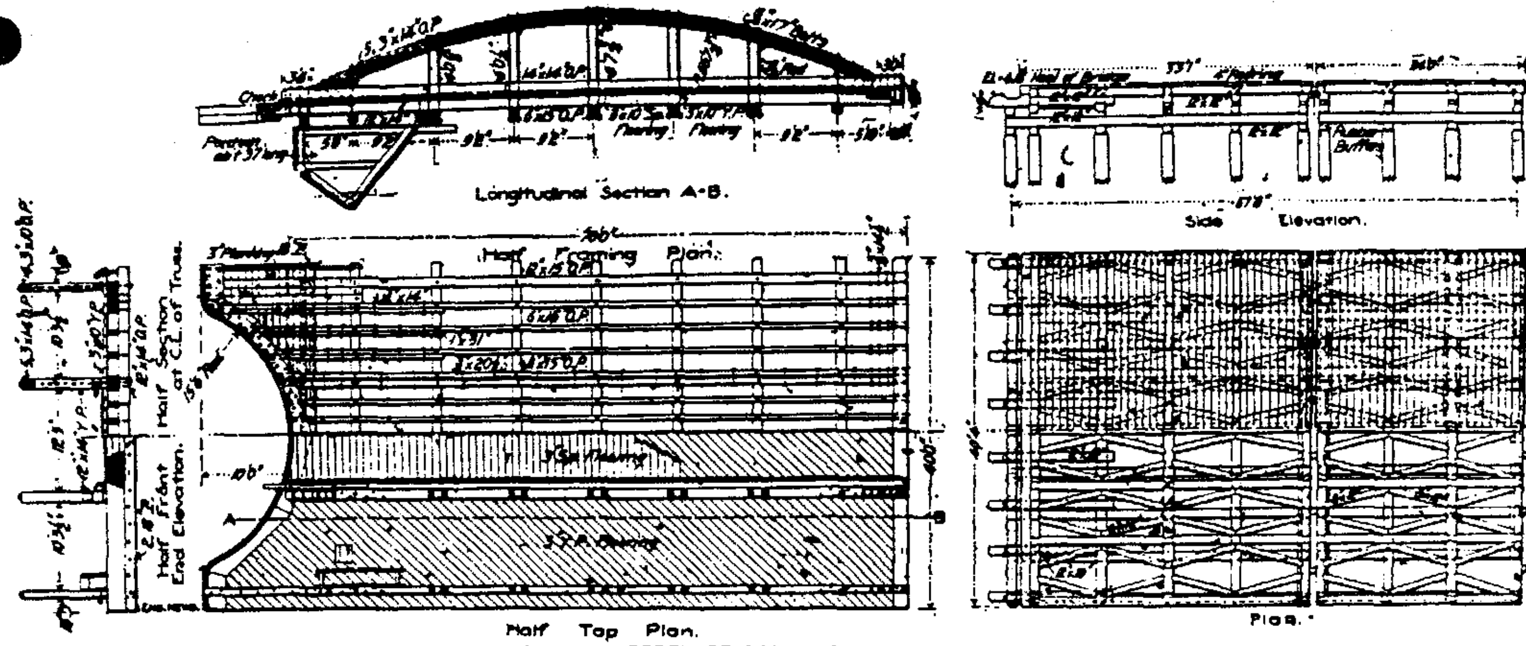


FIG. 12. MAIN FERRY BRIDGE AND BUFFER PLATFORMS.

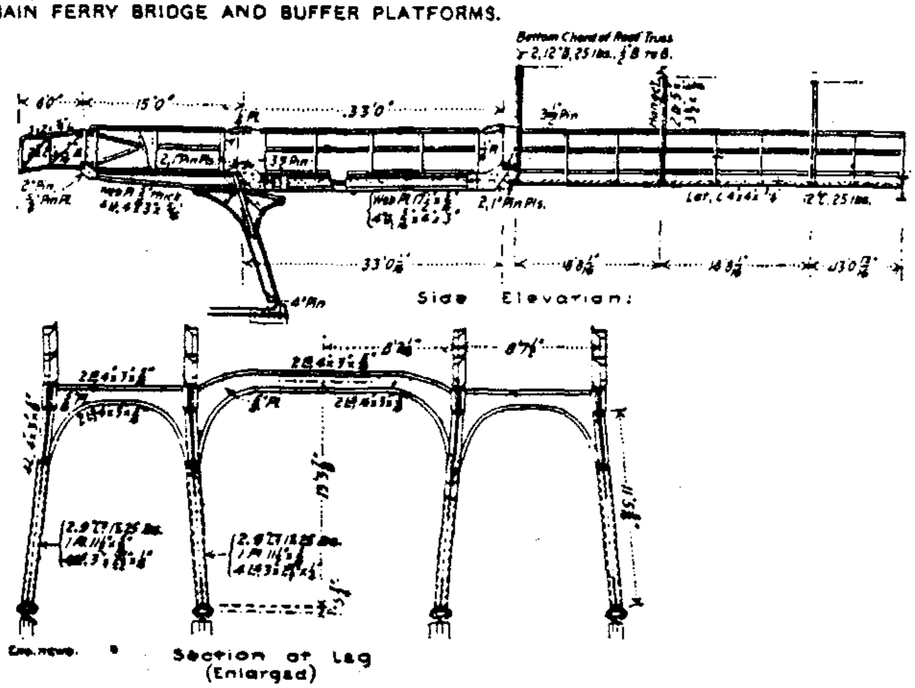


FIG. 13. OVERHEAD LANDING BRIDGE, WITH STERN PATENT SAFETY CANTILEVER SUPPORT.

and applied, for the purpose of reducing the danger of settlement cracks as far as possible.

COPPER WORK.

The ornamental copperwork of the exterior merits special attention. Holes for attaching the copper are left in the concrete by inserting rods through holes bored in the centering laid out accurately by template. The copper is formed in the shop to the architectural designs and reinforced with strap iron riveted to it on the back which is punched to correspond with the holes in the concrete. The sheets are then bolted to the concrete with copper-headed bolts, and all bolt-heads and seams are soldered. The pilasters of the east and west piers are formed out in the concrete to give a solid backing for the copper. Other pilasters, however, and the greater part of the projecting courses and moldings are merely formed in the copper, reinforced with steel angles and straps. Wood planking, supported on steel lookouts, is used under the gutters and cornices, but otherwise no woodwork is used for the support or attachment of copper-work. The copper-work of the tower has already been described above. Wherever copper and galvanized iron are in conjunction they are separated by felt and red-lead to prevent electrolysis. The copper-work is being furnished and erected by Hermen & Grace, of Brooklyn.

FIRE PROTECTION.

The structure of the building itself is considered thoroughly fire-resisting, but ample provision was made to guard against damage to the contents and passengers by providing metal-covered doors and hollow metal window frames and sash with wire-glass at all exposed points. This was done on the north and south sides and in the ferry slips, which are the only outside fire exposures, and also in rooms where inflammable material might be stored. The danger of panic was considered as well as the risk of property damage, and consequently all waiting-rooms and passenger concourses were separated from offices or store-rooms by fireproof doors and windows.

The building will be further protected by a system of wet firelines and stand-pipes having 38 2½-in. outlets each provided with a reel and 50 ft. of hose. There are also three permanent turret nozzles on the roof, similar to those in use on fireboats, which are capable of throwing a stream to any point of the roof.

This system is in connection with a system of underground fire-lines which extends throughout stream. Two hose connections are also placed on the outside of the building between the ferry slips, and controlled by valves within the building but operated from the outside to prevent freezing. There are three siamese connections on the river-front for fireboats and one on the street for a fire-engine to provide auxiliary pressure in case of necessity. These are dry, and are protected by check valves inside the building. All lines are thoroughly protected from freezing, and the main line on the east side of the ferry-house is run in the warm air duct for this purpose. This duct is described elsewhere. All pipe is extra heavy galvanized wrought iron, and all connections extra heavy malleable iron. The system is designed for a pressure of 300 lbs. per sq. in.

HEATING AND VENTILATION.

The entire terminal will be heated by a system of hot water (forced circulation), the plant being situated in the power-house, some 000 ft. distant. Hot water was adopted in preference to

In addition to direct heating by radiation distributed throughout the building, there is a supplementary indirect system. The main ferry concourse is heated by an air system under fan pressure, the fan and heating-room occupying one of the piers between the ferry slips. The heat is distributed through large ducts 10 × 9 ft., having outlets the entire length of the concourse, with register openings in each bay. A branch of this large main duct is taken across above the ceiling of the concourse and supplies air to the inside offices on the west side. The fan equipment consists of four 90-in. centrifugal cone pressure-fans, each capable of discharging 3,000,-000 cu. ft. of air per hour when running at 200 r. p. m. Each fan is belt-connected to a 15-HP. Sprague alternating-current motor.

In addition to this air supply the outer offices on the west of the ferry house, together with the main waiting-room and its subsidiary rooms, and the restaurant, kitchen and toilets in the railroad station proper, are ventilated by means of exhaust ducts connecting to three 70-in. and one 90-

t... nd supported on a special drop forged ball bearing. The heating of the main waiting-room is controlled by means of the Johnson thermostatic automatic regulation.

ELECTRICAL WORK.

High-tension, 2,200-volt, three-phase, 60-cycle alternating current will be generated at the company's power-house (600-ft. distant) and brought to two high-tension switchboards, where it will be reduced to 230 volts by means of single-phase transformers connected three-phase with half voltage taps, six bus-bars being therefore arranged on the switchboards for the lighting, which will supply three-wire circuits having 230 volts between outers. For the motors, the supply is three-phase three-wire. One switchboard will be located under the inclined concourse and will supply all that part of the building referred to as the railroad station, while the other, located in the ferryhouse, will supply that portion. A motor-generator set is also provided in connection with the railroad station switchboard for supplying direct current at 125 volts for the four ventilating exhaust fans and for the elevators. From the two main switchboards current will be distributed by means of 44 panel boards to the various motors and lights throughout the building.

LIGHTING.—The plans provide for about 6,500 incandescent lamps in the terminal. Of these 1,400 are employed in the five large electric signs; one having letters 6 ft. high, surmounting the river elevation of the ferryhouse, and four with 4-ft. letters on the sides of the tower. These signs are backed with steel plates perforated for the lights. Each light is set in a watertight receptacle which is attached to the plate from the ba... y a special device and furnished with flexib... nductors. The lamps can thus be removed from the back, which will effect large saving in the cost of maintenance of the signs.

The four clock-faces in the tower will be illuminated with incandescent lamps and reflectors, the dials being glass.

About 880 lights will be employed in decorative lighting on the exterior; the arches and imposts of the ferry slips on the east elevation, the pediments of the west elevation of the ferryhouse ... the cornice of the north elevation of the ...road station being outlined with lights placed ...ederal sign receptacles.

...e street front of the terminal and the train ...ourse is illuminated with twelve-light fix...s placed on the trusses of the marquise and ...ourse roof from 16 to 33 ft. on centers. The ...n-concourse on the first floor will be illuminated with 59 arc lamps.

About 3,900 lamps will be employed in interior lighting. Of these, 944 are in the main waiting-room, giving lighting power of 1.08 c. p. per sq. ft. of floor, or .032 c. p. per cu. ft. of space. These are so distributed as to fully illuminate the whole room and also to give ample light for reading on the seats. The ferry concourse on the second floor will have 0.31 c. p. per sq. ft. of floor area and .011 c. p. per cu. ft. of volume. It was not considered necessary to illuminate these concourses as brightly as the waiting-rooms, since they are used merely as passageways between trains, boats and the street.

An emergency gas system is provided for the case of breakdown of the electrical system. A few lights only are placed in each room, the intention being not to fully illuminate the building but merely to provide without delay sufficient light to handle the passenger traffic, and prevent panic and allow necessary business to be carried on.

TELEPHONE AND TELEGRAPH.—Two complete telephone systems will be installed, one for the Commissary Department and one for the Operating Department. These are to be of the intercommunicating type and will connect all the ...ces and rooms of these respective departments ... Washington. The tower clock has four faces each 12 ft. in diameter.

PLUMBING.

As the building stands over the water there is no main sewer line, but each soil and waste line empties direct into the river with a flap valve at the outlet to protect the traps from cold. Traps below the first floor were avoided on account of the danger of freezing, but in some cases where traps were necessary the steel beams are set a foot below grade and the space filled up with cinder concrete, in which pipes and traps are placed. Throughout the first floor each fixture discharges individually into the river, and siphonage of traps is prevented by mercury vents, no other venting being necessary. On the second floor each group of fixtures has its own soil and waste lines and stack, and the traps are vented in the usual manner. Except as modified by local conditions as described above, all plumbing work is installed as required by the rules and regulations of the Bureau of Buildings of the City of New York.

The following is the list of principal plumbing fixtures to be installed in the entire terminal:

Water closets	69
Lavatories	68
Urinals	37
Slop sinks	12
Bath tubs	3
Shower baths	5

All lavatories, slop sinks and kitchen sinks are provided with hot water, two Tobey water-heaters being provided for that purpose.

A very copious fresh water supply is provided, since all the ferryboats take water for their boilers while in the slips. The water mains in the ferryhouse are 6-in. and 4-in., and two tanks of 1,200 and 4,000 gals. capacity are provided in the attic space to insure uniform pressure and the quick delivery of a large quantity of water to the boats. Hose bibs are placed at frequent intervals throughout the team and train-concourses for cleaning purposes. The water system for the supply of boats and fixtures is entirely separate from the fire system described above, and is connected with the city mains.

FERRY LANDING BRIDGES.

The main ferry bridges, on the first floor, to which the ferryboat is made fast, are constructed of wood in the usual manner (see Fig. 12). The forward end of each bridge is supported by a pontoon, and is further suspended from the second (transverse) roof-truss of the slip by chains passing around overhead sheaves and operated by windlass on the bridge deck. At the rear end the bridge is hinged to the forward end of a double buffer-platform supported on piles, driven close together. The impact of the ferryboat is taken up by the inertia of these platforms and the resistance of the piles; the platforms are separated from the floor of the building proper by a 6-in. air space covered with a sliding plate.

From the balconies opening from the ferry-concourse passengers pass over bridges to the upper deck of boats. These bridges are for part of their length rigidly hung from the trusses above, but the outer sections are supported from the pontoon bridge below and rise and fall with it [the mean fall of tide between high and low water is 5 ft.]. The supporting device is the invention of the consulting engineer of the work, Mr. E. W. Stern, who has applied for patents. The outer end of the overhead bridge is 24 ft. beyond the point of support on the pontoon bridge, while the length of the suspended span is much less than the length of the pontoon bridges. This necessitates some sort of compensating device to make the rise and fall of the outer ends of the two bridges the same. The movable portion of the upper bridge is in three sections, as will be seen by reference to Fig. 13. The inner section is a simple girder span pin connected at each end. The middle section is a cantilever construction supported on posts, pin-connected at the bottom ... this structure the floor of the cantilever span remains practically horizontal and the pin of the apron bridge moves vertically the same height as the pin at the bottom of the post.

It will be noticed that there is a heavy bracket on the back of the post under the girder span, but in no way connected to it, and that the shoe at the bottom of the post is arranged to slide on a track. The object of this is to furnish a safeguard in case of accident due to the boat getting out of control and ramming the pontoon bridge with sufficient force to unseat it from its bearings [this has happened] and drive the bridge back on the ferryhouse floor for a considerable distance. Such an accident would result in a serious disaster if the pin at the foot of the post were immovable, since the upper bridge would crash down on the deck of the ferryboat. With the present device, however, the bracket would engage the girder span and the cantilever span be held up while the shoe slides along the track.

TRAIN SHED.

The train shed was designed by the Chief Engineer of the railway company, and is believed to be of an entirely new type. The defects inherent in the wide-span train shed and its great initial and maintenance cost are well known, and after considering several designs of steel arches of various span and types, it was decided to abandon the wide arch entirely and employ some form of open umbrella shed. As it was the intention to place the tracks in pairs to reduce the number of platforms, an umbrella shed of the usual type would necessitate a wide opening between the sheds, and to avoid this undesirable feature the present shed was designed. The essential features, Fig. 14, are a low roof of glass and concrete supported on steel trusses and a narrow continuous opening with aprons at the side extending as low as the smokestack of an engine, so that all smoke passes directly out of the shed to the outer air. The details of the construction are shown in Fig. 15. Cast-iron columns placed on the center line of each platform support transverse-arched plate girders. The top section of the column above the neck is cast square and the girders are bolted to the columns with through bolts. The bents are 27 ft., c. to c., and the total length of the shed, including the overhang at each end, is 607 ft. Expansion is taken care of by an expansion joint placed at every other column, that is, every 54 ft. Transversely, there are eight spans of arches, and the columns are 43 ft. 4½ ins. on centers, except the end spans which cover only one track, and are, respectively, 30 ft. 4½ ins. and 35 ft. 10½ ins. between centers of columns.

The smoke opening over each track is formed by a pair of light lattice stringers which are wrapped with expanded metal and cased solidly in concrete, the surface being floated smooth. The portion of each main girder where it crosses the opening is also encased in concrete, so that the smoke and gases come in contact with no steelwork. The aprons formed by the casing of the stringer at the side of the smoke opening extend low enough to catch all the smoke from the stacks. They also are carried a short distance above the roof as parapets and form an effectual protection to the platforms from driving rain. Narrow openings are pierced in the aprons every few feet, just under the roof, to allow the escape of any smoke or gas that may find its way under the shed. A continuous ventilator is placed on the central skylight at the highest level of the roof for a similar purpose.

Connecting each ... columns longitudinally is a steel member, built up of two channels and a plate in the form of a trough which serves both as a stringer to su... ...t the roof and as a rain water conductor. ... water passes off through leaders enclosed in the columns and thence into drains under the p...forms. The trough is lined